

## Louisiana State University LSU Digital Commons

---

Faculty Publications

Department of Geography & Anthropology

---

2016

# African Fire Cultures, Cattle Ranching, and Colonial Landscape Transformations in the Neo-Tropics

Andrew Sluyter

*Louisiana State University, [asluyter@lsu.edu](mailto:asluyter@lsu.edu)*

Chris S. Duvall

*University of New Mexico - Main Campus, [duvall@unm.edu](mailto:duvall@unm.edu)*

Follow this and additional works at: [https://digitalcommons.lsu.edu/geoanth\\_pubs](https://digitalcommons.lsu.edu/geoanth_pubs)



Part of the [Anthropology Commons](#), and the [Geography Commons](#)

---

### Recommended Citation

A. Sluyter and Chris Duvall. 2016. African Fire Cultures, Cattle Ranching, and Colonial Landscape Transformations in the Neo-Tropics. *Geographical Review* 106: 294-311

This Article is brought to you for free and open access by the Department of Geography & Anthropology at LSU Digital Commons. It has been accepted for inclusion in Faculty Publications by an authorized administrator of LSU Digital Commons. For more information, please contact [gcoste1@lsu.edu](mailto:gcoste1@lsu.edu).

# AFRICAN FIRE CULTURES, CATTLE RANCHING, AND COLONIAL LANDSCAPE TRANSFORMATIONS IN THE NEOTROPICS\*

ANDREW SLUYTER and CHRIS DUVAL

**ABSTRACT.** Fire regimes emerge partly from human activities that reflect cultural-ecological knowledge of the relationships among fire, vegetation, grazing, climate, and other variables, as well as social relations. More knowledge of such “fire cultures,” past and present, therefore remains necessary to better understand the causes and persistent consequences of landscape burning. In the neotropics, people have used fire for centuries to manage livestock pastures. Conventional wisdom has long posited that such practices derived solely from antecedent European and indigenous, Native American fire cultures. Analysis of accounts of rangeland burning from throughout the neotropics during colonial times, however, demonstrates that ranchers incorporated African fire cultures and that the timing of burning shifted from early during the dry season in the sixteenth century to late during the dry season by the nineteenth century. *Keywords:* *African diaspora, fire regime, historical ecology, livestock, neotropical savanna.*

*A* growing literature is demonstrating that Africans and their descendants contributed not only labor, but knowledge and creativity to the emergence of the colonial landscapes of the Americas (Carney 2001; Carney and Rosomoff 2009; Watkins 2011; Voeks and Rashford 2012). That scholarship challenges the assumptions that useful knowledge originated only in Europe and diffused to its colonies, that slavery so disempowered people that Africans played passive social roles, and that white males dominated in terms of initiative and creativity. Instead, African men and women actively helped create the novel places of the colonial Americas, from the landscapes of tidewater rice production in South Carolina to those of oil palm cultivation in Brazil, the vestiges of which persist in present-day social relations, vegetation patterns, and many other ways.

Such revisionism has also transformed the literature on the establishment of cattle ranching in the Americas. The cattle that Christopher Columbus brought to Hispaniola in 1493 multiplied as rapidly as indigenous populations declined, the herds expanding throughout the savannas of the Americas over the next four centuries (Sluyter 2012, fig. 1.1). Although that process involved people of European, African, indigenous, and mixed heritages, the conventional wisdom long maintained that there was “no compelling evidence of meaningful African influence in the cultures and adaptive systems of the various American cattle frontiers” (Jordan 1993, 311–12). As with the broader revisionist literature, however, recent scholarship has shown how Africans and their descendants played

---

key roles in establishing the use of live fencing, lassoing cattle from horseback, and other cattle herding practices (Duvall 2009; Sluyter 2012).

One aspect of that process that has received little attention involves the use of fire to manage rangeland: a practice that the conventional wisdom has long claimed derives from antecedent Spanish and indigenous knowledge, perhaps with some British influences (Otto 1986, 324; Jordan 1993, 70, 78–79). The use of fire to manage pastures remains a particularly important aspect of ranching to reconsider because it had notably widespread, persistent impacts on vegetation, carbon sequestration, and other aspects of landscapes related to climate change. Besides potentially countering biased assumptions that disregard African knowledge and creativity, therefore, more accurate histories of anthropogenic landscape burning remain essential to understanding global environmental change and improving mitigation policies (Jackson and Hobbs 2009; Keane and others 2009; Bowman and others 2011; Laris 2011; Archibald and others 2013; Hunter and Sluyter 2015). Fire regimes, meaning repeated patterns of burning at particular locations, differ in terms of frequency, intensity, seasonality, spatial extent, and other characteristics (Bond and Keeley 2005; Laris and Wardell 2006; Le Page and others 2010). Although biophysical factors such as climate set parameters at local to global scales, people regularly alter the spatial and temporal occurrence of burning. The literature on such anthropogenic fire regimes, herein termed “fire cultures” in order to signal that they encompass the knowledge, motives, and beliefs of particular social groups, nonetheless remains relatively modest relative their diversity and environmental impacts (Mbow and others 2000; Laris 2002; Bowman and others 2011).

This research contributes to that literature by determining whether, and if so to what effect, Africans influenced fire cultures in the colonial neotropics by, first, providing a general outline of fire ecology for the savanna biome of tropical West Africa and the neotropics. Second, it sketches the precolonial fire cultures of areas of precolonial Europe, Africa, and the neotropics relevant to providing antecedent knowledge for rangeland burning in the colonial neotropics. It then details six historical accounts from Brazil, Panama, the Dominican Republic, and Mexico that describe rangeland burning throughout the neotropics over the sixteenth century with sufficient specificity to determine whether herders of African, European, indigenous, or mixed origins were involved as well as how their practices compared and contrasted with precolonial antecedents (Figure 1). The discussion section then analyses the evidence for contributions to the establishment of neotropical fire cultures by those various groups and how practices varied over time and space as an element in the profound neotropical landscape transformations of the colonial period.

#### FIRE IN THE SAVANNA BIOME

The savanna biome in tropical latitudes roughly corresponds to tropical subhumid climates with a winter dry season (Köppen Aw). The annual transit of the

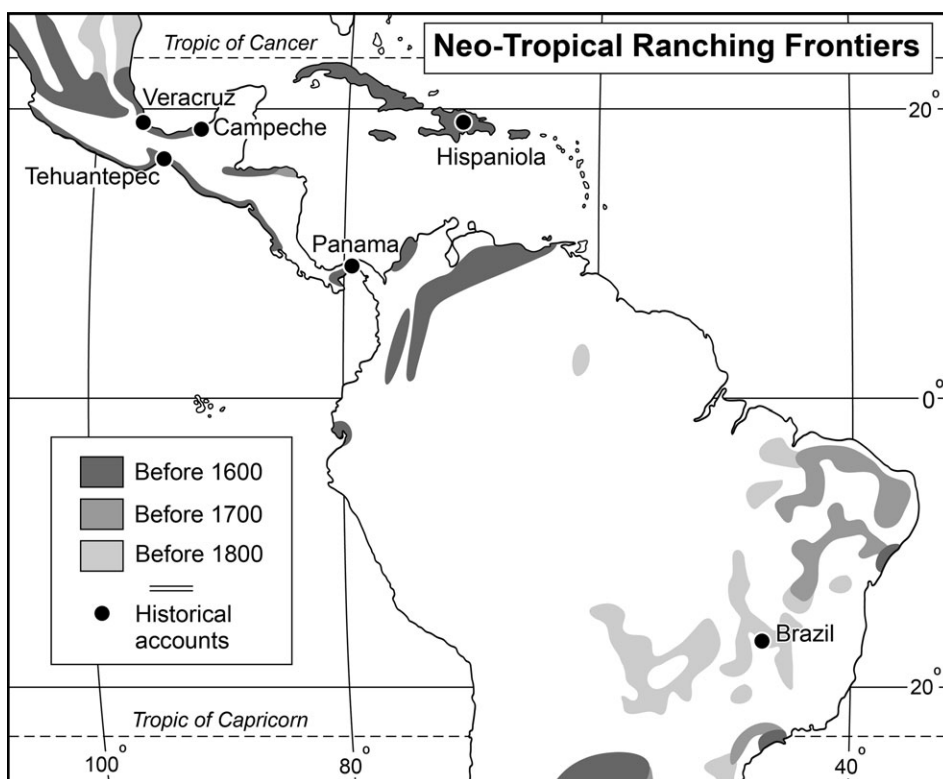


FIG. 1—Colonial ranching frontiers in the neo-tropics and the six historical accounts. Note that the small scale and centennial interval obscure spatial details such as small islands and temporal details such as the elimination of cattle ranching from the central highlands of Mexico after the mid-sixteenth century. Adapted from Sluyter 2012, fig. 1.1 (Cartography by Andrew Sluyter, Louisiana State University, September 11, 2015).

equatorial low and subtropical high pressure belts results in a highly seasonal precipitation regime with a summer rainy season and vegetation characterized by grasslands with scattered trees and shrubs. In West Africa, a belt of savanna that stretches across much of the continent reaches the Atlantic in a region known as Senegambia, defined by the valleys of the Senegal and Gambia rivers. To the south and north, respectively, the humid Guinean zone and Sahara desert receive more than 1,100 and less than 250 mm of annual precipitation. Within the savanna belt, annual precipitation decreases from the Sudanian zone in the south (900–1100 mm), through the Sudanian-Sahelian zone (500–900 mm) and into the Sahel (250–500 mm), with a concomitant northward transition from perennial and annual tall grasses with scattered trees to annual short grasses with scattered shrubs. Similar savannas also occur throughout the neotropics, from the Greater Antilles to the Llanos and Cerrado of South America, in part due to a comparable dominance by low pressure during the wet season and high pressure during the dry season, but also due to

rain shadow effects. In both West Africa and the neotropics, the abundant grasses of such savannas now support large herds of cattle.

Such savannas have fire regimes that affect the relative abundance of grasses versus trees and shrubs (Laris 2011). The highly seasonal precipitation regime makes savannas susceptible to extensive fires during the dry season. As soil moisture declines and grasses die or become dormant over the course of the dry season, their highly combustible, senescent foliage provides fine fuels for such fires, and many grass species have therefore evolved mechanisms to tolerate regular burning (D'Antonio and Vitousek 1992, 72–73). Annual grasses survive fires as seeds, which germinate and quickly mature once the rainy season begins. Perennial grasses may also survive as seeds, but additionally have extensive root systems unaffected by flames. If soil moisture is available after burning, fresh sprouts emerge from those root systems. Perennials do not rely on that fresh foliage to produce a seed crop, but the sprouts do allow photosynthesis to continue as long as soil moisture remains adequate. Fires early enough during the dry season, when residual soil moisture remains relatively high, can thereby result in the growth of fresh pasture. Fire tolerance also characterizes savanna trees and shrubs, although burning that spares mature individuals will kill seedlings, and fires that burn long and hot enough will consume even the largest trees.

Fire regime thereby plays a central role in shaping the relative dominance and extent of savanna grasses, trees, and shrubs (Laris 2008). Fires early during the dry season, for example, when vegetation and soil still contain substantial moisture, generally do not burn hot or long enough to do more than remove the leaves from mature trees, kill only seedlings, and remove senescent grass foliage. Perennial grasses benefit the most from such fires, gaining increased access to sunlight as well as nutrients in the form of ash, and therefore respond with fresh sprouts. In contrast, fires later during the dry season, when fuels are drier and burn hotter and longer, can kill mature trees while producing only ash until the rains begin again and seeds can germinate and grasses sprout. In addition to the timing of burning during the dry season, the frequency of fires also affects the balance between grasses, trees, and shrubs. Frequent burning, for example, reduces the supply of fine fuels so much that fires cannot burn long or hot enough to destroy trees and shrubs, enabling them to shade out and replace grasses in a process known as bush encroachment (Bassett and Koli Bi 2000). In contrast, infrequent burning results in the accumulation of sufficient fuel that when a fire does begin it burns hot and long enough to kill trees and shrubs, shifting the vegetation toward grasses.

Manipulation of those fire regimes by cattle herders—encompassed in the term “fire cultures”—emerges from social relations and sophisticated understanding of highly contingent relationships among not only burning and vegetation but grazing (Sluyter 2002, 176–77). For example, many herders know precisely when to burn rangeland in order best to suppress the growth of trees

and shrubs that compete with grasses for water, nutrients, and sunlight. Yet if market conditions encourage herders to overgraze the range, the fuel supply can become so depleted that fires no longer burn hot or long enough to prevent the encroachment of woody vegetation into pastures.

#### ANTECEDENT FIRE CULTURES

Fire cultures from Africa, Europe, and the precolonial neotropics provided potential antecedent knowledge for rangeland burning in the colonial neotropics. None would have transferred directly to the novel social and environmental relationships that emerged in the colonial Americas. Yet many of the cattle herders of European, African, indigenous, and mixed descent that expanded across the neotropics beginning in 1493 had long-standing and sophisticated knowledge of the use of fire to manage vegetation. The permutations of such fire cultures remain complex, contingent, variable, and poorly known, but nonetheless permit some generalizations.

#### WEST AFRICAN ANTECEDENTS

People have shaped fire regimes for several hundred thousand years in Sub-Saharan Africa as a whole and for at least the last three millennia in West Africa (Ballouche and Neumann 1995; Breunig and others 1996, 113; Bird and Cali 1998). Evidence for cattle in the Sudanian zone dates to at least 3000 BP, and landscape management by herders becomes apparent about 1000 BP in the paleoecological record (Macdonald and MacDonald 2000; Höhn and Neumann 2012; Dueppen 2012). Such data cannot determine the purposes or detailed characteristics of ancient fires with any specificity, and people likely burned landscapes to drive game, clear agricultural fields, and other purposes in addition to managing rangeland to graze cattle and other livestock (Sowunmi 1985, 128; Breunig and others 1996, 113).

The more recent, documentary record reveals some characteristics of that ancient fire culture. While medieval Arabic sources for West Africa do not describe landscape management, European accounts from the eighteenth century suggest that people regularly used burning as an element in farming, hunting, warfare, honey collecting, and fire prevention practices along the coast (Bosman 1705, 477). Most provide few details, but Francis Moore (1738, 188, 193) very specifically dated the burning he observed in Senegambia in 1724 to between January 2 and 11. That timing falls less than halfway through the dry season, which lasts from October through May, with February marking the middle of the burning season (Le Page and others 2010). Michel Adanson recorded burning in Senegambia in November of 1752, even earlier during the dry season, and claimed such burning took place annually (1758, 294). Mungo Park provided an account of rangeland burning during the 1790s from further inland in the Sudanian zone, in what is now southwestern Mali, and while he does not provide specific dates his observations imply burning early enough

during the dry season to allow grass to sprout on the basis of residual soil moisture: “Whenever the grass is sufficiently dry, the Negroes set it on fire”; “This annual burning is soon followed by a fresh and sweet verdure” (1799, 259–260).

None of those accounts claim that rangeland management was the motive for burning. Moore suggested that burning grassland improved visibility for hunting (1738, 188, 193). Adanson noted that fires “render the country passable” and assumed that they served “to prepare [fields] for being sown the next year” (1758, 294). Only Park implied that the purpose was to stimulate fresh pasture during the dry season (1799, 259–260). Whatever the specific purpose in each case, burning before the middle of the dry season nonetheless provides the only characteristic consistently recorded in the sparse historical record of the fire cultures of the West African savanna. That timing also agrees with many twentieth-century ethnographies that herders of the Sudanian zone in West Africa favor burning early during the dry season in order to stimulate senescent perennial grasses to produce fresh sprouts for their livestock (Hoffmann 1985; Bruzon 1994; César 1994; Fairhead and Leach 1996; Bassett and Boutrais 2000; Bassett and Koli Bi 2000; Mbow and others 2000; Laris 2002).

#### EUROPEAN ANTECEDENTS

While tropical savanna does not occur in Europe, and therefore its precolonial fire cultures do not include knowledge of that biome, European herders have long burned rangelands to kill woody vegetation and stimulate grass growth (Webb 1998; Pykälä 2000). Colonists of Portuguese, Spanish, French, and British origins embarked for the Americas from several areas in Atlantic Europe with extensive areas of rangeland with distinct fire cultures (Jordan 1993, 14–17).

In southwestern Europe, the cattle herders occupied coastal marshes, among which the Marismas of Spain provide the best understood example of the herding ecology involved and how it incorporated annual burning in relation to the Mediterranean climate of hot, dry summers and cool, wet winters (Sluyter 2012, 8–10). As the winter rains ended and floodwaters receded, herders branded their calves and drove the stock into the marshes each June to graze the lush new growth. Over the dry months of summer, Solano winds blowing out of the Sahara parched the matorral shrublands and open oak woodlands on the surrounding hills, and the ranchers set the herbaceous understory ablaze just before the winter rains returned each October. As the marshes began to flood, mounted herders rounded up the cattle and drove them upslope into the freshly sprouted perennial and annual grasses of the hill pastures.

In northwestern Europe, open-range cattle herding occurred in the Auvergne and Brittany regions of France as well as in the British highlands (Sluyter 2012, 7–12). There, however, temperature rather than precipitation drove the annual cycle of the herding ecologies, including the use of fire. With



plentiful rainfall throughout the year, but cold winters during which perennial grasses became dormant and annual ones died, herders burned rangelands mainly to kill encroaching trees and remove senescent grass in late winter in order to promote fresh growth as temperatures warmed (Otto 1986, 316; Jordan 1993, 47).

Both of those European fire cultures burned late during the dormant season, whether at the end of the cold winter or the end of the dry summer. That characteristic differentiates them from the fire culture of the West African savanna, which favored burning before the middle of the dry season so that perennial grasses could use residual soil moisture to sprout fresh pasture.

#### NEOTROPICAL ANTECEDENTS

While the precolonial neotropics lacked livestock, people used fire for millennia before 1492 for many purposes other than rangeland management. Although details of indigenous fire cultures remain largely unknown, the primary purposes related to agriculture and hunting (Piperno, Bush, and Colinvaux 1990; Denevan 1992).

To prepare land for agriculture, farmers burned fields late during the dry season. Documents from the early colonial period reveal that indigenous farmers preferred burning late in the dry season because fuels were dryer and sustained hotter fires that effectively cleared woody plants (Denevan 2001, 39–40, 56, 72, 119–22; Whitmore and Turner 2001, 114). Moreover, the resulting layer of fertile ash did not blow away before the rains returned to germinate crops, and weeds did not have enough time to invade clearings before crops began to sprout. Because surrounding landscapes were also most combustible at that time of year, of course, some fires spread beyond fields and had broader impacts on forests and savannas.

Hunters, in contrast, burned savannas to promote habitat preferred by game animals and to drive them into traps (Johannessen 1963, 61). The lack of large grazers in the lowland neotropics between their Pleistocene extinctions and their colonial reintroduction would, logically, have encouraged burning that promoted shrubs for browsers, like deer, rather than grasses for grazers. Frequent burning would have promoted such vegetation by reducing fuel supplies and therefore the intensity of the fires.

Descriptions of savannas from the early colonial period nonetheless emphasize open grasslands with few trees, suggesting burning late in the dry season over many preceding centuries (Sauer 1966, 285–87; Sluyter 2002, 177). Some Europeans immediately recognized the potential of such vegetation as rangeland. For instance, when Hernán Cortés landed at Veracruz in 1519 he found the lands “as pleasant to the eye as they are fertile, very suitable and agreeable to travel through and pasture all types of livestock” (1988 [1519], 20).



## RANGELAND BURNING IN THE COLONIAL NEOTROPICS

The evidence to determine whether any of that antecedent knowledge influenced the fire cultures that became established on the colonial ranching frontiers of the neotropics remains sparse. Paleoecological records such as soil profiles and sediment cores generally cannot resolve the characteristics or purposes of burning (Sluyter 1997, 141; Sluyter and Dominguez 2006; Dull and others 2010). Fire scars on trees provide an exception with annual, and sometimes seasonal, temporal resolution, but have had limited application in tropical lowlands (Rozendaal and Zuidema 2011; Aldrich 2014). In contrast, written accounts provide eyewitness evidence and, sometimes, enough detail to determine whether herders of African, European, indigenous, or mixed origin were involved in rangeland burning as well as how their practices compared and contrasted with precolonial antecedents. Many such accounts are too brief or general to do more than identify the presence of some type of rangeland burning by an unspecified group (Hanson 1683, 54; Browne 1756, 306; Oldmixon 1969 [1741], vol. 2, 394). Nonetheless, six accounts from Brazil, Panama, the Dominican Republic, and Mexico describe rangeland burning throughout the neotropics from the late sixteenth through the early nineteenth century in sufficient detail to distinguish what seems to be a key difference among the three antecedent fire cultures: burning during the first half of the dry season by West Africans and burning late during the dry season by Europeans and indigenous peoples.

## VERACRUZ, 1570S

The earliest account of rangeland burning with relevant details is Arias Hernández's 1571 description of the environs of Veracruz, the principal port for colonial New Spain. He recorded that the ranchers set fire to the savanna in order to maintain forage quality: the plains were "habitually burned at Christmas" and "all made into pasture" (Archivo General de Indias, Indiferente General, leg. 1529, no. 5, f. 5r). Since the dry season runs from November to May in Veracruz, the burning occurred well before the midpoint. Rangeland burning became so prevalent in colonial New Spain that one viceroy promulgated a law against it, believing that fires reduced the supply of forage for cattle and sometimes threatened towns (Beleña 1991 [1787], vol. 1, pt. 2, p. 62). Rangeland burning nonetheless persisted, as demonstrated by a nineteenth-century account of the practice in Veracruz during the dry season, albeit without any indication of the month in which it occurred (Sartorius 1859 [1852], 9). A sediment core from near Veracruz yielded charcoal that also confirms widespread burning throughout the colonial period, although again without being able to specify at what time of year (Sluyter 1997, 141).

Both Spaniards and West Africans were involved in ranching in Veracruz and had antecedent experience with rangeland burning. Gregorio de Villalobos, originally from the Marismas, introduced cattle to New Spain in 1521 in the

Veracruz lowlands (Sluyter 2012, 29–34). Many other Spaniards followed his lead, and by 1600 Veracruz was one of the colony's principal ranching districts. Hernán Ruiz de Córdova, for example, assembled an immense ranch near Veracruz. Most of the *vaqueros* (cowboys) who tended his herds were African, an enslaved workforce of “two hundred blacks” (Archivo General de Indias, Indiferente General, leg. 1529, no. 5, f. 5v). Other *vaqueros* of African origin were free and earned wages or owned ranches, such as Juan El Negro and Benito El Negro in the Pánuco district to the north of Veracruz (Sluyter 2012, 44).

Many of New Spain's Africans came from Senegambia, where the Sahelian and Sudanian savanna zones meet the Atlantic, and likely had as much antecedent knowledge of cattle herding as Spaniards such as Villalobos. The Trans-Atlantic Slave Trade Database (TASTD) records that 35,430 Senegambians disembarked between 1531 and 1650 in Spain's mainland colonies from Colombia to Mexico, about 17 percent of the total ([www.slavevoyages.org](http://www.slavevoyages.org)). The number of Senegambians increased with the volume of the trade: 1,607 total during 1531–1550, averaging 85 per year; 9,704 during 1551–1600, about 198 per year; 24,119 during 1601–1650, or 494 per year. However, the proportion of Senegambians decreased: 85 percent of total arrivals for 1531–1550, 20 percent for 1551–1600, and 15 percent for 1601–1650.

#### CAMPECHE, 1670S

A century later and 500 kilometers eastward along the Gulf Coast, William Dampier observed rangeland burning in Campeche (1697, vol. 2, 58). The vegetation, climate, and herding ecology were similar to Veracruz and involved many ranchers and *vaqueros* of Spanish and Senegambian origins. Yet during Dampier's visit in 1676, cattle herders set the savanna ablaze in May—at the end of the dry season.

The [soil] of the Savannahs is generally black and deep, producing a coarse sort of sedgy Grass. In the latter end of the dry time, we set fire to it, which runs like Wild fire, and keeps burning as long as there is any Fuel, unless some good shower of rain puts it out. Then presently springs up a new green Crop, which thrives beyond all belief (Dampier 1697, vol. 2, 58).

#### TEHUANTEPEC, 1670S

Another seventeenth-century account, from the southern Isthmus of Tehuantepec, suggests burning early during a dry season that lasts from November through April. In an account first published in 1674, the Dominican chronicler Francisco de Burgoa (1934) described the Zoque, an indigenous group that became renowned *vaqueros* on the district's ranches (Zeitlin 1989, 43–46). One of the Zoque practices involved burning rangeland early enough during the dry season for residual soil moisture to support re-sprouting: “in the dry season when the wooded hills lack water and grass, in order to sustain the feral cows

and bulls they burn the fields and cut the seedlings that have grown in the main plains so that they sprout green" (Burgoa 1934 [1674], vol. 2, 410).

The Trans-Atlantic Slave Trade Database and other records indicate that many of the *vaqueros* of the Isthmus of Tehuantepec were of West African origin, some of them Senegambians. The detailed records of the Marquesado del Valle, the estate granted to Hernán Cortés by the Crown, reveal that its ranches in the southern isthmus used *vaqueros* from three distinct groups: Zoque, forced to work as part of the rotating labor draft imposed on indigenous communities; African slaves; and free workers of indigenous, African, Spanish, and mixed origins (Gutiérrez-Brockington 1989, 99–142). The records also reveal varied origins among the enslaved *vaqueros*: some were creoles born in New Spain or the Caribbean and others came directly from Senegambia or elsewhere in Africa (Gutiérrez-Brockington 1989, 128–41). The number of enslaved workers declined dramatically over the seventeenth century, replaced nearly entirely by wage laborers from villages near the ranches. Some were indigenous and others formerly enslaved Africans who had either been manumitted or freed themselves and lived in communities such as the village of Petapa, "founded by mulattos and free blacks, the *vaqueros* of which work on the ranches for salaries" (Burgoa 1934 [1674], vol. 2, 409; Gutiérrez-Brockington 1989, 144–45).

#### PANAMA, 1570S

Another early report of rangeland burning comes from Panama, recorded by a member of Francis Drake's 1572–1573 expedition against Nombre de Dios, the principal port on the Caribbean side of the isthmus (Nichols 1932 [1628], 300–1). Drake struck an alliance with escaped slaves, known as *cimarrones* in Spanish and maroons in English. They lived in communities in the interior where they grew crops and raised livestock, making occasional raids on Spanish settlements along the coast in order to free more slaves. There were some 3,000 maroons in Panama at the time, with the records compiled in the Trans-Atlantic Slave Trade Database indicating that many had Senegambian origins (Anonymous 1932 [1573], 72). The names of maroon leaders, such as Juan Vaquero and Antón Mandinga, indicate backgrounds in cattle herding and origins in West Africa (Anonymous 1932 [1577], 118; Frias Trejo 1932 [1578], 217; Maluenda 1932 [1578], 205). Vaquero means cowboy in Spanish, and the Mandinka people occupy a territory that arcs from Senegambia southward to Liberia and inland to Mali.

Nichols (1932 [1628], 300–1) noted that Drake's maroon allies regularly burned rangeland. While just inland from Panama Viejo, the Pacific terminus of the royal highway that crossed the isthmus from Nombre de Dios, he noted a savanna of grass so tall that "the top be too high for an Oxe to reach" and that "the inhabitants are faine to burn it thrise in the year that it may bee able to feede their Cattle, of which they have thousands" (Nichols 1932 [1628], 300). He specified that they were "wont to put fire to it, for the space of five or six

miles together, which notwithstanding, after it is thus burnt within three days springeth up fresh like greene corne” (Nichols 1932 [1628], 300–1).

Nichols observation occurs in his journal in mid-February, while Drake’s company was on its way to ambush a Spanish pack train carrying Peruvian treasure along the royal highway, but whether he actually saw the burning at that time or merely recorded what the maroons told him remains unclear. If he was an eyewitness to the burning, it occurred early in the dry season, which lasts from January through April on the Pacific side of the isthmus. On the one hand, that timing would explain the rapid sprouting on the basis of residual soil moisture. On the other hand, he noted that the maroons burned rangelands three times per year in order to keep the rapidly growing grass palatable to the cattle, suggesting that it also occurred at times other than mid-February.

#### HISPANIOLA, 1796S

Médéric Louis Moreau de Saint-Méry observed range fires on Hispaniola in the eighteenth century (1796, vol. 1, 77). Ranchers on the Spanish part of the island, now the Dominican Republic, burned late in a dry season that lasts from November through April: “in the month of April, upon the approach of the rains.” The practice was so widespread that winds carried smoke into Saint-Domingue, the French side of the island, precipitating a distinctive type of fog (Moreau de Saint-Méry 1796, vol. 1, 78).

Within a few decades of the introduction of cattle into Hispaniola in 1493, nearly all the *vaqueros* were Fulani, Wolof, and Mandinka from West Africa (Thornton 1998, 135). The Trans-Atlantic Slave Trade Database records the disembarkation of 11,354 enslaved Africans in the ports of Hispaniola between 1525 and 1783. Nearly half of them came from West Central Africa, but a substantial number 765 (6.7 percent) had Senegambian origins, with more than half arriving in the sixteenth century. They would have carried substantial experience with cattle herding and rangeland burning across the Atlantic and apparently dominated among the island’s *vaqueros*.

#### BRAZIL, 1810S

The last of the six accounts comes from South America, courtesy of a French botanist named Auguste de Saint-Hilaire who visited the extensive *cerrado* (savanna) of interior Brazil during the early nineteenth century (Saint-Hilaire 1824, xxx–xxxiii; Mistry 1998a, 428). In 1817, he reached the border between the states of Minas Gerais and Goiás at the end of May, early during a dry season that lasts through September, and observed extensive *queimadas*, areas of savanna that ranchers had recently burned to “provide the cattle with fresh, more tender nourishment” (Saint-Hilaire 1824, xxxiii). He also observed many other instances of rangeland burning, with the timing of burns, or whether they occurred at all in any given year, varying greatly from place to place depending on specific purpose, the timing of rainfall, accumulated soil moisture, the type

and condition of the vegetation, time since the last burn, pest population, and other variables (Saint-Hilaire 1847, part 1, 69–70, 136, 202, 257, 293–94; part 2, 165–66, 173, 187, 203). Apparently, the *vaqueiros* set the fires by riding across the savanna while trailing a burning stem of bamboo (Saint-Hilaire 1847, part 1, 69).

Thousands of enslaved Africans, Portuguese, and their descendants herded livestock in the *cerrado* (Klein and Luna 2010, 71–72, 105). Of the some 12.5 million Africans that slavers seized and shipped to the Americas, the Trans-Atlantic Slave Trade Database records 1,437,358 Brazilian disembarkations, nearly 12 percent of the total. Some 89 percent of those to reach Brazil had origins in West Central Africa or the Bight of Benin, but 52,443 (3.7 percent) came from Senegambia. According to Saint-Hilaire, Africans and their descendants demographically dominated some settlements in the *cerrado* by the early nineteenth century (1824, xxxi). The ranchers and *vaqueiros* he encountered burning rangelands would have been of diverse, mixed origins that included indigenous, Portuguese, Senegambians, and others.

The use of fire to manage vegetation continues to the present in the *cerrado* among farmers and ranchers of varied origins (Mistry 1998a, 426–28; 1998b, 328–30; Mistry and others 2005, 367). It includes the practices of burning late in the dry season to clear fields for agriculture and early in the dry season to promote sprouting of grass for pasture.

#### DISCUSSION

The six accounts, summarized in Table 1, illustrate the complexity of the process through which rangeland burning became established in the colonial neotropics, its geographical and historical variation, and the involvement of actors of African as well as other origins. In four of the six accounts, the fire culture was similar to the West African savanna: burning relatively early in the dry season so that grasses could sprout on the basis of residual soil moisture rather than so late that new growth relied on the start of the rainy season. Only in the accounts from Hispaniola and Campeche did the herders burn exclusively late in the dry season. In the case of Panama, the account explicitly identifies the herders as being African in origin, with the name of a leader among them more specifically suggesting Mandinka, West African origins. In the accounts from Veracruz, Campeche, Hispaniola, and Brazil, African involvement is circumstantial, with the records of the slave trade and other sources documenting the presence of many Senegambians and other Africans on ranches, but no specific identification of who was burning rangeland. In the case of Tehuantepec, the herders burning rangeland were indigenous, Zoque *vaqueros*, but the presence of many *vaqueros* of Senegambian origin and their work on ranches together with indigenous *vaqueros* indicates a cross-cultural influence that was the reverse of the more typical pattern in the neotropics, where maroons and their descendants often incorporated and preserved indige-

nous ecological knowledge rather than vice versa (Carney and Rosomoff 2009, 97–99, 118–21). The accounts of burning three times per year in sixteenth-century Panama and highly variable timing in the nineteenth-century cerrado accord with current practices in parts of the Sudanian savanna where topographic and edaphic variation cause some patches of vegetation to retain residual soil moisture for longer into the dry season than others and, therefore, encourage people to burn those patches sequentially over the course of several months (Mbow and others 2000; Laris 2002, 2011).

The temporal pattern evident in the historical accounts suggests—although certainly does not demonstrate—a relatively unstudied aspect of colonial landscape transformation that involves the interactions of indigenous demographic collapse, land-use and climate change, fire cultures, and rangeland stocking rates. As indigenous populations declined, often by as much as ninety percent or more over the first century of colonization, the frequency and geographic scope of burning late in the dry season associated with precolonial agriculture also decreased (Dull and others 2010). As a consequence, many accounts describe the gradual invasion of savannas and moribund agricultural fields by woody vegetation over the sixteenth century (Sauer 1966, 283–88; Sauer 1967 [1958], 90–91; Denevan 1992, 372–73). Annual burning did not fade away everywhere during colonial times, however, because ranchers replaced farmers in areas of savanna. Rather, as the historical accounts from Veracruz, Panama, and Tehuantepec suggest, the timing of burning shifted over the sixteenth century from late in the dry season, as per indigenous fire culture, to early in the dry season, as per West African fire culture. The fires set by ranchers thereby stimulated forage production up to the middle of the dry season but prevented the accumulation of fine fuels necessary for the hotter, longer burning fires in the late dry season that would have prevented woody vegetation from

TABLE 1—SUMMARY OF THE SIX HISTORICAL ACCOUNTS IN CHRONOLOGICAL ORDER.<sup>1</sup>

PLACE	CENTURY	TIMING	HERDER ORIGINS
Veracruz	Late 16th	Early dry season	African, Spanish
Panama	Late 16th	Early dry season and perhaps other times	African
Tehuantepec	Mid 17th	Early dry season	African, indigenous, Spanish
Campeche	Late 17th	Late dry season	African, Spanish
Hispaniola	Late 18th	Late dry season	African, Spanish
Brazil	Early 19th	Early dry season and other times	African, Portuguese

<sup>1</sup>Sources: Arias Hernández (Archivo General de Indias, Indiferente General, leg. 1529, no. 5, f. 5r); Philip Nichols (1932 [1628], 300–1); Francisco de Burgoa (1934 [1674], vol. 2, 410); William Dampier (1697, vol. 2, 58); Médéric Louis Moreau de Saint-Méry (1796, vol. 1, 77–78); Auguste de Saint-Hilaire (1824, xxx–xxxiii).

encroaching on savannas. As invasion by shrubs and trees reduced pasture quality, authorities outlawed rangeland burning in an attempt to preserve grasslands but failed because, as is so often the case, the social and environmental relations were more complex than understood (Laris and Wardell 2006). The introduction of livestock by itself had tipped the balance in favor of woody over herbaceous taxa. As the cattle refilled an ecological niche vacated by the Pleistocene herbivores with which many of the native shrubs and trees had coevolved, they browsed their fruits and pods, disseminated their seeds through digestive tracts, and thereby helped them to invade the savannas (Sauer 1967 [1958], 92; Janzen and Martin 1982; Sluyter 2002, 177). With woody vegetation beginning to dominate savannas by the late seventeenth century, the fire culture of the ranchers shifted to burning later in the dry season to try to combat the invasion, as apparent in the Campeche and Hispaniola cases. That practice accords well with the current purpose and timing of burning in those places: late in the dry season to combat encroachment by trees and shrubs (McDowell 1972; Le Page et al 2010).

The types of grasses involved in the colonial transformation of neotropical rangelands also would have influenced that process. Only the historical account from sixteenth-century Panama describes the grass involved in enough detail to even hazard an identification; the “stalke as big as a great wheaten reed, which hath a blade issuing from the top of it” suggests *Paspalum saccharoides*, a perennial neotropical grass that botanists described as common in the savannas near Panama Viejo in the early twentieth century (Nichols 1932 [1628], 300; Lantz 1912, 213). By the seventeenth century, however, ranchers were introducing African grasses that had a distinct relationship to both cattle and fire. Many millennia of association between livestock and grasses in Africa ensured that they achieved a greater symbiosis with cattle than grasses native to the neotropics (Parsons 1972). Ranchers introduced African grasses such as Guinea grass (*Panicum maximum*), Pará grass (*Brachiaria mutica*), molasses grass (*Melinis minutiflora*), and jaraguá grass (*Hyparrhenia rufa*) into the neotropics, and they proved so much more palatable and nutritious than native grasses that cattle favored the introduced grasses when grazing and preferentially propagated them until they became established from Mexico to Brazil. Moreover, those African invasives are also well adapted to annual burning early in the dry season, readily catching fire and rapidly sprouting on the basis of residual soil moisture (D’Antonio and Vitousek 1992, 75–76). One study in the cerrado even found that fires in stands of molasses grass produced hotter temperatures, higher flames, and longer lasting burns that were more damaging to trees and shrubs than fires in native grasses (Mistry 1998a, 437).

#### CONCLUSIONS

The conventional wisdom that colonial rangeland burning in the neotropics derives from antecedent European and indigenous practices rather than African



ones has, on the basis of these initial six cases alone, become unsustainable. West Africans came to the neotropics with an existing, thorough knowledge of rangeland burning. They became cattle herders throughout the neotropics, whether enslaved vaqueros in Veracruz, free laborers in Tehuantepec, ranch owners in Pánuco, or maroons in Panama. And burning early in the dry season, characteristic of the Sudanian savanna but not European cattle herding or indigenous agriculture, is evident in four of the six historical accounts. In sum, Africans had both useful knowledge of rangeland burning and ample opportunity to contribute it, and they did so alongside people of European, indigenous, and mixed origins.

That process set in motion widespread, yet little-understood landscape transformations far beyond those driven by the collapse of the indigenous population alone. Rather than continue to emphasize and overgeneralize European and indigenous roles in that process, more detailed historical ecologies that cast Africans (and African grasses) in central roles are necessary. Further archival and published documentary sources, as a complement to paleoecological records from sediment cores and tree rings, will help to test whether there actually was a temporal progression toward burning later in the dry season over the course of the colonial period and how it related to climate change and other types of landscape transformations.

#### REFERENCES

- Adanson, M. 1759. *A Voyage to Senegal*. London: Nourse and Johnston.
- Aldrich, S., C. Lafon, H. Grissino-Mayer, and G. DeWeese. 2014. Fire History and its Relations with Land Use and Climate over Three Centuries in the Central Appalachian Mountains. *Journal of Biogeography* 41 (11): 2093–2104.
- Anonymous. 1932[1573]. Document 28 [City of Nombre de Dios to the Crown, May 14, 1573]. In *Documents Concerning English Voyages to the Spanish Main 1569-1580*, edited by I. A. Wright, 72–73. London: Hakluyt Society.
- Anonymous. 1932[1577]. Document 40 [Diego de Sotomayor, deposition, Panama, April 17, 1577]. In *Documents Concerning English Voyages to the Spanish Main 1569-1580*, edited by I. A. Wright, 72–73. London: Hakluyt Society.
- Archibald, S., and others 2013. Defining Pyromes and Global Syndromes of Fire Regimes. *Proceedings of the National Academy of Sciences* 110 (16): 6442–6447.
- Ballouche, A., and K. Neumann. 1995. A New Contribution to the Holocene Vegetation History of the West African Sahel. *Vegetation History and Archaeobotany* 4 (1): 31–39.
- Bassett, T. J., and J. Boutrais. 2000. Cattle and Trees in the West African Savanna. In *Contesting Forestry in West Africa*, edited by R. Cline-Cole and C. Madge, 242–263. Aldershot, U.K.: Ashgate.
- , and Z. Koli Bi. 2000. Environmental Discourses and the Ivorian Savanna. *Annals of the Association of American Geographers* 90 (1): 67–95.
- Beleña, E. V., ed. 1991[1787]. *Recopilación Sumaria de Todos los Autos Acordados de la Real Audiencia y Sala del Crimen de Esta Nueva España*, 2 vols. Mexico City: Universidad Autónoma de México.
- Bird, M. I., and J. A. Cali. 1998. A Million-Year Record of Fire in Sub-Saharan Africa. *Nature* 394 (20 August): 767–769.
- Bond, W. J., and J. E. Keeley. 2005. Fire as a Global ‘Herbivore’: The Ecology and Evolution of Flammable Ecosystems. *Trends in Ecology and Evolution* 20 (7): 387–394.
- Bosman, W. 1705. *A New and Accurate Description of the Coast of Guinea*. London: Knapton and Others.

- Bowman, D., and others. 2011. The Human Dimensions of Fire Regimes on Earth. *Journal of Biogeography* 38 (12): 2223–2236.
- Breunig, P., K. Neumann, and W. VanNeer. 1996. New Research on the Holocene Settlement and Environment of the Chad Basin in Nigeria. *African Archaeological Review* 13 (2): 111–145.
- Browne, P. 1756. *The Civil and Natural History of Jamaica*. London: Osborne and Shipton.
- Bruzon, V. 1994. Les pratiques du feu en Afrique subhumide. In *À la croisée des parcours*, edited by C. Blanc-Pamard and J. Boutrais, 147–162. Paris: ORSTOM.
- deBurgoa, F. de. 1934 [1674]. *Geografica Descripción*, 2 vols. Mexico City: Talleres Graficos de la Nación.
- Carney, J. 2001. *Black Rice: The African Origins of Rice Cultivation in the Americas*. Cambridge, Mass.: Harvard University Press.
- , and R. Rosomoff. 2009. In *the Shadow of Slavery: Africa's Botanical Legacy in the Atlantic World*. Berkeley: University of California Press.
- César, J. 1994. Gestion et aménagement de l'espace pastoral. In *À la croisée des parcours*, edited by C. Blanc-Pamard and J. Boutrais, 111–145. Paris: ORSTOM.
- Cortés, H. 1988 [1519]. *Cartas de Relación*. Mexico City: Editorial Porrúa.
- Dampier, W. 1697. *A New Voyage Round the World*, 2 vols. London: James Knapton.
- D'Antonio, C. M., and P. M. Vitousek. 1992. Biological Invasions by Exotic Grasses, the Grass/Fire Cycle, and Global Change. *Annual Review of Ecology and Systematics* 23: 63–87.
- Denevan, W. 1992. The Pristine Myth: The Landscape of the Americas in 1492. *Annals of the Association of American Geographers* 82 (3): 369–385.
- . 2001. *Cultivated Landscapes of Native Amazonia and the Andes*. Oxford, U.K.: Oxford University Press.
- Dueppen, S. 2012. Cattle in the West African Savanna. *Journal of Archaeological Science* 39 (1): 92–101.
- Dull, R., R. Nevle, W. Woods, D. Bird, S. Avnery, and W. Denevan. 2010. The Columbian Encounter and the Little Ice Age: Abrupt Land Use Change, Fire, and Greenhouse Forcing. *Annals of the Association of American Geographers* 100 (4): 755–771.
- Duvall, C. 2009. A Maroon Legacy? Sketching African Contributions to Live Fencing Practices in Early Spanish America. *Singapore Journal of Tropical Geography* 30 (2): 232–247.
- Fairhead, J., and M. Leach. 1996. *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic*. Cambridge, U.K.: Cambridge University Press.
- Frias Trejo, D. de. 1932[1578]. Document 67 [Diego de Frias Trejo to the Crown, Panama, May 15, 1578]. In *Documents Concerning English Voyages to the Spanish Main 1569-1580*, edited by I. A. Wright, 215–219. London: Hakluyt Society.
- Gutiérrez-Brockington, L. 1989. *The Leverage of Labor: Managing the Cortés Haciendas in Tehuantepec, 1588–1688*. Durham, N.C.: Duke University Press.
- Hanson, F. 1683. *The Laws of Jamaica Passed by the Assembly, and Confirmed by His Majesty in Council*. London: Charles Harper.
- Hoffmann, O. 1985. *Pratiques Pastorales et Dynamique du Couvert Végétal en Pays Lobi*. Paris: ORSTOM.
- Höhn, A., and K. Neumann. 2012. Shifting Cultivation and the Development of a Cultural Landscape during the Iron Age in the Northern Sahel of Burkina Faso. *Quaternary International* 249 (1): 72–83.
- Hunter, R., and A. Sluyter. 2015. Sixteenth-Century Soil Carbon Sequestration Rates Based on Mexican Land-Grant Documents. *The Holocene* 25 (5): 1–19.
- Jackson, S. T., and R. J. Hobbs. 2009. Ecological Restoration in the Light of Ecological History. *Science* 325 (5940): 567–569.
- Janzen, D. H., and P. S. Martin. 1982. Neotropical Anachronisms: The Fruits the Gophotheres Ate. *Science* 215 (4528): 19–27.
- Johannessen, C. 1963. *Savannas of Interior Honduras*. Berkeley: University of California Press.
- Jordan, T. 1993. *North American Cattle-Ranching Frontiers*. Albuquerque: University of New Mexico Press.
- Keane, R. E., P. F. Hessburg, P. B. Landres, and F. J. Swanson. 2009. The Use of Historical Range and Variability (HRV) in Landscape Management. *Forest Ecology and Management* 258 (7): 1025–1037.
- Klein, H. S., and F. V. Luna. 2010. *Slavery in Brazil*. New York City: Cambridge University Press.

- Lantz, D. E. 1912. Proceedings of the Society and Affiliated Societies. *Journal of the Washington Academy of Sciences* 2: 211–214.
- Laris, P. 2002. Burning the Seasonal Mosaic: Preventative Burning Strategies in the Wooded Savanna of Southern Mali. *Human Ecology* 30 (2): 155–186.
- . 2008. An Anthropogenic Escape Route from the ‘Gulliver Syndrome’ in the West African Savanna. *Human Ecology* 36 (6): 789–805.
- . 2011. Humanizing Savanna Biogeography: Linking Human Practices with Ecological Patterns in a Frequently Burned Savanna of Southern Mali. *Annals of the Association of American Geographers* 101 (5): 1067–1088.
- , and D. A. Wardell. 2006. Good, Bad, or “Necessary Evil”? Reinterpreting the Colonial Burning Experiments in the Savanna Landscapes of West Africa. *Geographical Journal* 172 (4): 217–290.
- Le Page, Y., and others 2010. Seasonality of Vegetation Fires as Modified by Human Action. *Global Ecology and Biogeography* 19 (4): 575–588.
- MacDonald, K., and R. H. MacDonald. 2000. The Origins and Development of Domesticated Animals in Arid West-Africa. In *The Origins and Development of African Livestock*, edited by R. M. Blench and K. C. MacDonald, 127–162. London: UCL Press.
- Maluenda, C. de. 1932[1578]. Document 63 [Carlos de Maluenda to the Crown, Panama, February 23, 1578]. In *Documents Concerning English Voyages to the Spanish Main 1569-1580*, edited by I. A. Wright, 205–206. London: Hakluyt Society.
- Mbow, C., T. T. Nielsen, and K. Rasmussen. 2000. Savanna Fires in East-Central Senegal. *Human Ecology* 28 (4): 561–583.
- McDowell, R. E. 1972. *Improvement of Livestock Production in Warm Climates*. San Francisco: W. H. Freeman.
- Mistry, J. 1998a. Fire in the Cerrado (Savannas) of Brazil. *Progress in Physical Geography* 22 (4): 425–448.
- . 1998b. Decision-Making for Fire Use Among Farmers in the Savannas of Central Brazil. *Journal of Environmental Management* 54 (4): 321–334.
- , and others 2005. Indigenous Fire Management in the Cerrado of Brazil: The Case of the Krahô of Tocantins. *Human Ecology* 33 (3): 365–386.
- Moore, F. 1738. *Travels into the Inland Parts of Africa*. London: Cave.
- Moreau de Saint-Méry, M. L. 1796. *Description topographique et politique de la partie espagnole de l'Isle Saint-Domingue*, 2 vols. Philadelphia: The Author.
- Nichols, P. 1932 [1628]. Sir Francis Drake Revived: Calling Upon this Dull or Effeminate Age to Follow his Noble Steps for Gold and Silver. In *Documents Concerning English Voyages to the Spanish Main 1569-1580*, edited by I. A. Wright, 245–326. London: Hakluyt Society.
- Oldmixon, J. 1969[1741]. *The British Empire in America, Containing the History of the Discovery, Settlement, Progress and State of the British Colonies on the Continent and Islands of America*, 2 vols. London: Brotherton.
- Otto, J. S. 1986. Open-Range Cattle-Ranching in the Florida Pinewoods. *Proceedings of the American Philosophical Society* 130 (3): 312–324.
- Park, M. 1799. *Travels in the Interior Districts of Africa*. London: The Author.
- Parsons, J. J. 1972. Spread of African Pasture Grasses to the American Tropics. *Journal of Range Management* 25 (1): 12–17.
- Piperno, D. R., M. B. Bush, and P. A. Colinvaux. 1990. Paleoenvironments and Human Occupation in Late-glacial Panama. *Quaternary Research* 33 (1): 108–116.
- Pykälä, J. 2000. Mitigating Human Effects on European Biodiversity through Traditional Animal Husbandry. *Conservation Biology* 14 (3): 705–712.
- Rozendaal, D., and P. Zuidema. 2011. Dendroecology in the Tropics. *Trees* 25 (1): 3–16.
- Saint-Hilaire, A. de 1824. *Histoire des Plantes les Plus Remarquables du Brésil et du Paraguay*. Paris: A. Belin.
- . 1847. *Voyages Dans l'Intérieur du Brésil*, 3 vols. Paris: A. Belin.
- Sartorius, C. 1859 [1852]. *Mexico: Landscapes and Popular Sketches*, translated by Thomas Gaspey. London: Trübner.
- Sauer, C. 1966. *The Early Spanish Main*. Berkeley: University of California Press.
- . 1967 [1958]. Man in the Ecology of Tropical America. In *Land and Life*, edited by J. Leighy, 182–193. Berkeley: University of California Press.

- Sluyter, A. 1997. Regional, Holocene Records of the Human Dimension of Global Change: Sea-Level and Land-Use Change in Prehistoric Mexico. *Global and Planetary Change* 14 (3–4): 127–146.
- . 2002. *Colonialism and Landscape: Postcolonial Theory and Applications*. Lanham: Rowman & Littlefield.
- . 2012. *Black Ranching Frontiers: African Cattle Herders of the Atlantic World, 1500–1900*. New Haven, Conn: Yale University Press.
- , and G. Dominguez. 2006. Early Maize (*Zea mays* L.) Cultivation in Mexico: Dating Sedimentary Pollen Records and its Implications. *Proceedings of the National Academy of Sciences* 103 (4): 1147–1151.
- Sowunmi, M. A. 1985. The Beginnings of Agriculture in West Africa. *Current Anthropology* 26 (1): 127–129.
- Thornton, J. 1998. *Africa and Africans in the Making of the Atlantic World*. Cambridge, U.K.: Cambridge University Press.
- Voeks, R., and J. Rashford (eds.). 2012. *African Ethnobotany in the Americas*. New York: Springer.
- Watkins, C. 2011. Dendezeiro: African Oil Palm Agroecologies in Bahia, Brazil, and Implications for Development. *Journal of Latin American Geography* 10 (1): 9–33.
- Webb, N. R. 1998. The Traditional Management of European Heathlands. *Journal of Applied Ecology* 35 (6): 987–990.
- Whitmore, T. M., and B. L. Turner, II. 2001. *Cultivated Landscapes of Middle America on the Eve of Conquest*. Oxford: Oxford University Press.
- Wright, I. A. ed. 1932. *Documents Concerning English Voyages to the Spanish Main 1569–1580*. London: Hakluyt Society.
- Zeitlin, J. 1989. Ranchers and Indians on the Southern Isthmus of Tehuantepec: Economic Change and Indigenous Survival in Colonial Mexico. *Hispanic American Historical Review* 69 (1): 23–60.